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Alimentary canal anatomy and diet of the nurseryfish, *Kurtus gulliveri* (Perciformes: Kurtidae), from the Northern Territory of Australia

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ABSTRACT

The alimentary canal and diet of nurseryfish, *Kurtus gulliveri,* are described based on 50 specimens (average size 223 mm SL) collected from the Adelaide River, near Darwin, Northern Territory, during April-July 2001. The mouth is large, angled at about 45°, and opens terminally and slightly superiorly. Small conical teeth are present in bands on the premaxillary and dentary and in patches on the palatine and basibranchials. The gill rakers are long and flat with small teeth at their distal ends. The stomach is very muscular and capable of sizable distension. There are 8-11 pyloric caeca at the junction of the stomach and intestine. The intestine is relatively short, and the anus is located much more anteriorly than in most fishes. Sixty percent of the stomachs and 64% of the intestines contained food items, whereas 84% of the entire gastrointestinal tracts contained prey. Twenty-four percent of the stomachs were full or distended. Arthropods (prawns, isopods, insect larvae) and teleosts are the most frequently ingested prey.

KEYWORDS: *Kurtus gulliveri*, nurseryfish, diet, anatomy, isopods, prawns, alimentary canal, gastrointestinal tract, stomach, intestine.

INTRODUCTION

Kurtus gulliveri Castelnau, 1878, is found in turbid, tidal rivers of coastal northern Australia and southern New Guinea (Berra 2001). This unusual-looking, hatchet-shaped, hump-headed fish is very compressed with a long anal fin and a narrow caudal peduncle (Fig. 1). It is remarkable for its unique mode of parental care whereby the males carry the eggs on a hook on their head (Weber 1910: fig. 2), hence the common name, nurseryfish. Very little is known about the basic biology of this species. Previously published literature on nurseryfish diet and anatomy is sparse. Roberts (1978) reported that most nurseryfish examined from the Fly River of Papua New Guinea had empty stomachs, and a few had eaten small fishes. Guide books (Lake 1971; Merrick and Schmida 1984; Allen 1989, 1991; Larson and Martin 1990) mention that nurseryfish are carnivorous and consume fishes and crustaceans but provide no further details. De Beaufort (1914) described some aspects of the skeleton and soft anatomy.

A study to learn more details of nurseryfish life history was begun on the Adelaide River, near Darwin, Northern Territory, in early 2001. The results reported here are part of that study. The Adelaide River, named for the British dowager queen by L. R. Fitzmaurice of H.M.S. *Beagle* in 1839, originates in the hills south of Darwin. It meanders with dramatic wet season (December-April) increases in volume into Adam Bay, an inlet of the Timor Sea on Clarence Strait, 51 km northeast of Darwin. It is tidal for 121 km and navigable for 130 km of its 180 km length (Messel *et al.* 1979). There are two high and low tides each day with a tidal variation as much as 7 m in the lower reaches. A downstream constriction of the river known as the "Narrows" creates a bottleneck to the passage of outgoing water as the tide recedes. This prevents the previous tide from draining completely before the following tide invades the river. The time between high and low water (approximately 6-7 hours) is not sufficient to drain the river to the low tide level before the tide rises again. As a result the maximum tidal variation in the vicinity of Marrakai

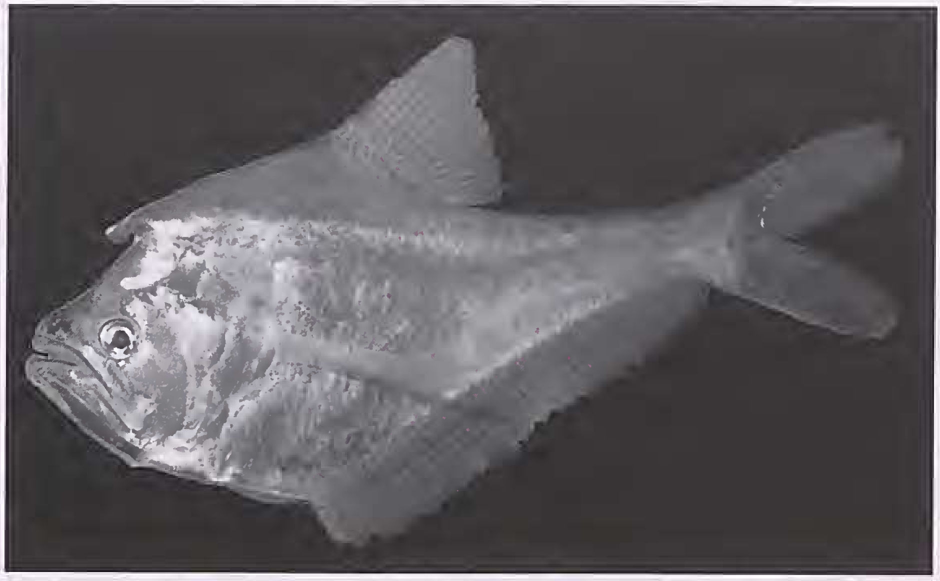

Fig. 1. Male *Kurtus gulliveri* photographed live in a 5,000 litre aquarium at the Territory Wildlife Park.

Creek is about 4 m. The water is turbid for much of the year. River banks are mud with mangroves and sedges. Lower tributaries are "saltwater creeks" up to 19.5 km from Adam Bay. "Freshwater creeks" begin at about 31.6 km from the mouth (Messel *et al.* 1979).

METHODS

Nurseryfish were collected with an 11 cm mesh gill net (2.5 m deep x 15 m long) from the Adelaide River (mouth = 12°13.4'S 131°13.5'E) from 18 April through 16 July in water ranging from brackish to fresh (28-0 ppt). The net was set during daylight hours in the middle of major, mangrove-lined tributaries such as brackish water "Number 2 Creek", also known as "C Creek", at river km 8.0 (12°16.9'S 131°21.8'E, upstream from the "Narrows") and the fresh water Marrakai Creek at river km 82.1 (12°42'S 131°19.7'E, upstream from the Arnhem Highway bridge). Messel *et al.* (1979: fig. 3.2, p. 13) provided a map of the river and a description of ecological conditions. The net was checked every 20 minutes for 2-3 hrs. The net could only safely and effectively be worked for approximately 2 hrs before high tide to ½ hr after high tide and again about 3-4 hrs after the turn of the tide due to the strong tidal movement and the inability of the net to hold the bottom. A cast net was employed to sample fish along shallow mud banks. Additionally, nine nurseryfish were collected by seine from ponds of a commercial barramundi farm along the Adelaide River flood plain near Middle Point.

Large fish were placed on ice immediately. The gastrointestinal (GI) tracts were removed in the laboratory several hours later and preserved in 10% formalin. Small fish were preserved in formalin immediately upon capture. Fifty GI tracts from fish ranging in size from 105 mm standard length (SL) to 290 mm SL (average SL = 223 mm) were dissected. The contents of the stomachs and intestines were examined separately under a binocular microscope. Stomach fullness was recorded on the following scale; 0 = empty, 0.5 = trace, 1 = one-quarter full, 2 = one-half full, 3 = three-quarters full, 4= full, 5 = distended (Fig. 2) (Berra *et al.* 1987). Individual prey items were counted, measured, and identified to the lowest taxonomic level that the state of digestion allowed using Bruce (1983),

Fig. 2. Stomach of a 221 mm SL nurseryfish distended with the paelaemonid prawn, *Macrobrachium equidens*.

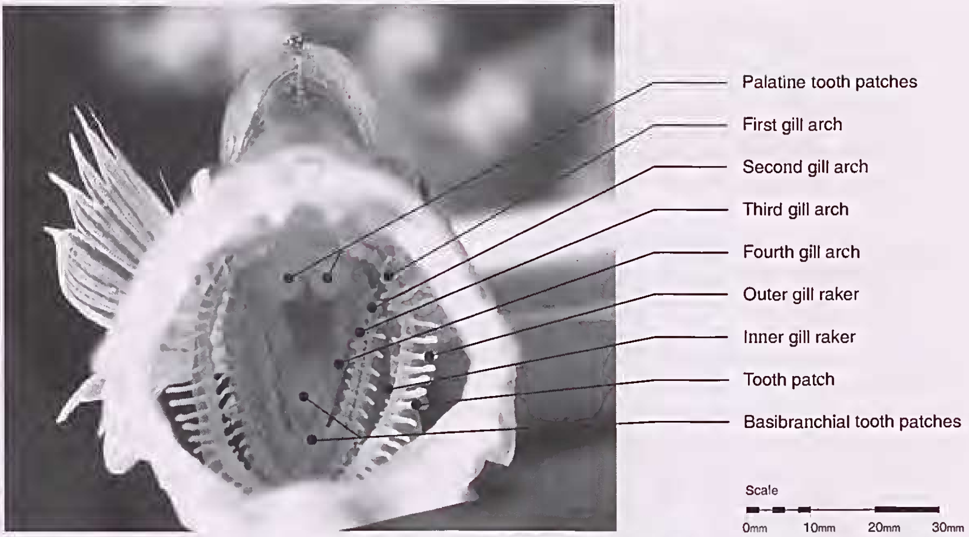

Fig. 3. Pharyngeal cavity of female nurseryfish showing outer and inner gill rakers, and palatine and basibranchial tooth patches.

Dore and Frimodt (1987), Grey *et al.* (1983), and Jones and Morgan (1994).

RESULTS

Anatomy. The mouth of nurseryfish is large, terminal and directed slightly superiorly at approximately a 45° angle (Fig. 1). The elongate premaxilla lies over the toothless maxilla, and its anterior edge is studded with a band of small, conical teeth. There is a diastema on the upper jaw between the left and right premaxillae. Left and right anterior projections of the palatine also have clusters of small conical teeth (Fig. 3). The dentary is toothed along its anterior surface, and the width of the tooth rows decreases sharply about mid-way posteriorly. Teeth of both the upper and lower jaws can be seen and felt when the mouth is closed. The lateral edge of the first gill arch has 21-22 long, thin, flattened gill rakers (Fig. 3). The upperside of the arch and the inside of the gill rakers are covered with tiny teeth. There are 18 stubby projections (inner gill rakers) on the medial surface of the first arch that fit into the spaces between the gill rakers of the second arch (Fig. 3). There are 18 paddle-like gill rakers on the second arch. These are shorter and broader than those of the first arch. The second gill arch has about 12 club-shaped inner gill rakers that fit into the approximately 16 outer gill rakers on the third arch which has 10 club-like inside projections. The fourth arch has about 10 stubby gill rakers. Small conical teeth are present in two paired patches on the pharyngeal surfaces of the basibranchials at the junction of the third gill arches and behind the fourth gill arches, respectively (Fig. 3). The anterior tooth patch is small and triangular, and the posterior patch is elongate with larger teeth.

The oesophagus leads into a very thick-walled stomach lined with rugae that allow for substantial distension (Fig. 2). The small intestine joins the stomach along its ventral surface. There are 8-11 pyloric caeca that radiate from the junction of the stomach and small intestine (Fig. 4). These finger-like projections are embedded in intestinal fat stored in the surrounding mesenteries and are difficult to see. The transparent gall bladder lies on the right, anterior side of the pyloric caecal mass, adjacent to the large liver. The relatively short intestine continues posteriorly and ventrally

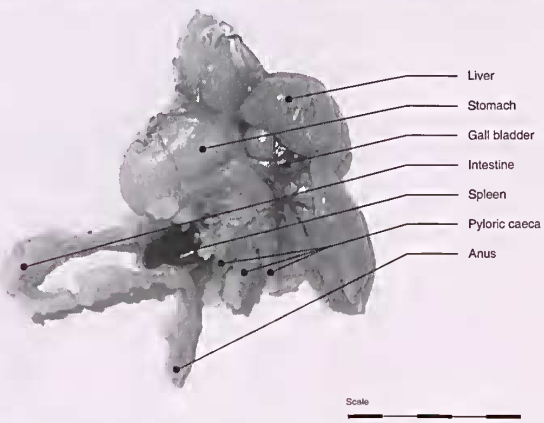

Fig. 4. Nurseryfish gastrointestinal tract from stomach to anus as viewed from the right side. The head of the fish is to the right. Fat deposits have been partially removed for clarity, and the intestine has been dissected free from mesenteries and displaced slightly posteriorly to show its length.

exiting the body anterior to the gonads. The viscera are crowded anterodorsally into a triangular body cavity rather than extending posteriorly and horizontally into an elongate coelom typical of most perciform fishes. The anus of nurseryfish is located in front of the anal fin and between the left and right ventral fins, far more anteriorly than in most fishes.

Diet. Of the 50 nurseryfish dissected, 60% had food items in the stomach and 64% had food in the intestine (Table 1). Twenty-four percent of the stomachs were full or distended with food. Forty-two GI tracts (84%) had prey items either in the stomach, intestine or both. Principal food items were arthropods and teleosts (Table 2). The largest stomach contents were prawn pieces that measured 53, 45, 35, and 30 mm. Food items measuring 20-53 mm made up 27% of the sample, and items 6-19 mm composed 53%. The remaining stomach contents (20%) consisted of food fragments from 0.1-5 mm.

Nurseryfish maintained in a 5000 litre aquarium at the Territory Wildlife Park (south of Darwin) were fed a "cloud" of hundreds of live prawns (*Caridina longirostris, Macrobrachium* sp.) collected from nearby wetlands. This produced an "alert" reaction in the normally placid, hovering nurseryfish school. As the prawns dispersed, the nurseryfish swam rapidly through the path of their target and opened their cavernous mouth near the prey items. The prey was engulfed by the forward motion of the fish and presumably by the vacuum action of the large mouth's expansion. Feeding behaviour was observed by both of us and other staff of the Territory Wildlife Park on several occasions.

DISCUSSION

The enormous mouth of nurseryfish suggests that they engulf prey. This was confirmed by our feeding observations. The fine dentition on the jaws and in the oral cavity is well adapted to holding prey items such as small arthropods and fishes. Processing by the tooth patches on the palatine and basibranchials may explain why most food items like prawns and fishes were found as fragments even though they were ingested whole. This volumetric reduction would facilitate digestion in the rather small body cavity. Additionally, the long, thin, toothed gill rakers form an efficient screen to retain prey of the size eaten by nurseryfish.

Table 1. Fullness of stomachs and intestines of 50 *Kurtus gulliveri* (105-290 mm SL) collected in the Adelaide River from April-July 2001. 0=empty, 0.5=trace, 1=1/4 full, 2=1/2 full, 3= ¾ full, 4= full, 5= distended (after Berra *et al.* 1987).

Fullness	Stomach		Intestine	
(0-5)	No.	%	No.	%
0	20	40	18	36
0.5	8	16	11	22
1	5	10	6	12
2	5	10	10	20
3	0	0	3	6
4	5	10	1	2
5	7	14	1	2

Table 2. Number and percent occurrence of food items in the diet of *Kurtus gulliveri* from the Adelaide River, N.T. based on 42 specimens with food in their gastrointestinal tract.

Taxa	No.	% Occurrence
Phylum Arthropoda		
Class Malacostraca		
Order Decapoda		
Prawn fragments	24	57.1
Crab larvae	1	2.4
Order Isopoda		
Alitropus typus	4	9.5
Class Insecta		
Insect fragments	7	16.7
Phylum Chordata		
Teleostei		
Fish fragments	10	23.8
Organic matrix	12	28.6
Mangrove leaf	1	2.4

Prawn fragments were the most common item in the diet and were represented in 57% of the specimens (Table 2). Aside from *Macrobrachium equidens* (Fig. 2), species identification was not possible due to the finely divided nature of the carapace fragments. Posterior portions of prawn rostra and their size distribution suggest that, in addition to the Paelaemonidae, species of the families Penaeidae and Atyidae are also eaten. All three prawn families occur in the shallow waters along the mangrove-covered mud banks of the study area. The organic matrix (Table 2), which was found only in the intestines, is identical in texture and consistency to the gut contents of prawns collected from the Adelaide River. Its presence in nurseryfish is probably due to digestion of prawns and consequent release of their gut contents. Ingestion of a mangrove leaf was most likely incidental to foraging on prawns along the mud banks.

A single crab larval (zoea) fragment was found, but it was too small to identify. Our field observations show that the isopod *Alitropus typus* (Aegidae) is common on the surface and gills of barramundi (*Lates calcarifer*) and other fishes taken from the Adelaide River, including nurseryfish. They were found in the stomach or intestine of nearly 10% of the nurseryfish. Insects, represented by pieces of compound eyes and partial mouthparts, constituted a major dietary category for seven of the nine nurseryfish from the barramundi ponds. Insects were not found in the GI tracts of fishes from the Adelaide River. This is possibly due to the fact that the grassy banks around the ponds provided habitat for insect larvae, unlike the river banks which are covered twice each day at high tide. At least one odonate (dragonfly) and one coleopteran (beetle) larval fragment were recognisable, however further identification was not possible.

Fish fragments including scales, fin rays, vertebrae, and small pieces of muscle were found in nearly 24% of the specimens (Table 2). In one case, a large piece of fish torso (26 mm), including portions of the spinal column, distended the stomach. The presence of a dorsal fin spine attached to this mass suggests a perciform fish.

In addition to the ubiquitous *Crocodylus porosus*, which often swam over our nets, some predatory species taken with nurseryfish in our gill nets included *Carcharinus leucas*, an undescribed species of *Glyphis*, *Pristis microdon*, and *Lates calcarifer*. However, examination of the gut contents of 15 *L. calcarifer* from about 40-60 cm SL revealed no identifiable nurseryfish remains.

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